

We claim:

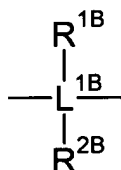
1. A monocyclopentadienyl complex which comprises the structural feature of the formula (Cp)(-Z-A)_mM (I), where the variables have the following meanings:

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Cp is a cyclopentadienyl system,

Z is a bridge between A and Cp of the formula,

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where

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L^{1B} are each, independently of one another, carbon or silicon,

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R^{1B}, R^{2B} are each, independently of one another hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{3B}₃, where the organic radicals R^{1B} and R^{2B} may also be substituted by halogens and the two radicals R^{1B} and R^{2B} and/or R^{1B} or R^{2B} and A may also be joined to form a five- or six-membered ring,

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R^{3B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{3B} may also be joined to form a five- or six-membered ring,

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A is an unsubstituted, substituted or fused, five-membered heteroaromatic ring system,

M is a metal selected from the group consisting of titanium in the oxidation state 3, vanadium, chromium, molybdenum and tungsten and

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m is 1, 2 or 3.

2. A monocyclopentadienyl complex as claimed in claim 1 having the formula (Cp)-(-Z-A)_mMX_k (VI), where the variables have the following meanings:

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Cp is a cyclopentadienyl system,

Z is a bridge between A and Cp of the formula,



where

10 $\text{L}^{1\text{B}}$ are each, independently of one another, carbon or silicon,

15 $\text{R}^{1\text{B}}, \text{R}^{2\text{B}}$ are each, independently of one another hydrogen, $\text{C}_1\text{-C}_{20}$ -alkyl, $\text{C}_2\text{-C}_{20}$ -alkenyl, $\text{C}_6\text{-C}_{20}$ -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or $\text{SiR}^{3\text{B}}_3$, where the organic radicals $\text{R}^{1\text{B}}$ and $\text{R}^{2\text{B}}$ may also be substituted by halogens and the two radicals $\text{R}^{1\text{B}}$ and $\text{R}^{2\text{B}}$ and/or $\text{R}^{1\text{B}}$ or $\text{R}^{2\text{B}}$ and A may also be joined to form a five- or six-membered ring,

20 $\text{R}^{3\text{B}}$ are each, independently of one another, hydrogen, $\text{C}_1\text{-C}_{20}$ -alkyl, $\text{C}_2\text{-C}_{20}$ -alkenyl, $\text{C}_6\text{-C}_{20}$ -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals $\text{R}^{3\text{B}}$ may also be joined to form a five- or six-membered ring,

25 A is an unsubstituted, substituted or fused, five-membered heteroaromatic ring system,

M is a metal selected from the group consisting of titanium in the oxidation state 3, vanadium, chromium, molybdenum and tungsten,

30 m is 1, 2 or 3,

X are each, independently of one another, fluorine, chlorine, bromine, iodine, hydrogen, $\text{C}_1\text{-C}_{10}$ -alkyl, $\text{C}_2\text{-C}_{10}$ -alkenyl, $\text{C}_6\text{-C}_{20}$ -aryl, alkylaryl having 1-10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^1R^2 , OR^1 , SR^1 , SO_3R^1 , OC(O)R^1 , CN, SCN, β -diketonate, CO, BF_4^- , PF_6^- or a bulky noncoordinating anion,

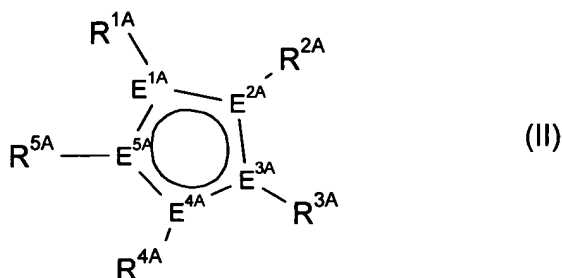
40 $\text{R}^1\text{-R}^2$ are each, independently of one another, hydrogen, $\text{C}_1\text{-C}_{20}$ -alkyl, $\text{C}_2\text{-C}_{20}$ -alkenyl, $\text{C}_6\text{-C}_{20}$ -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^3_3 , where the organic radicals $\text{R}^1\text{-R}^2$ may

also be substituted by halogens and two radicals R^1 - R^2 may also be joined to form a five- or six-membered ring,

R^3 are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^3 may also be joined to form a five- or six-membered ring and

k is 1, 2, or 3.

3. A monocyclopentadienyl complex as claimed in claim 1 or 2, wherein the cyclopentadienyl system Cp has the formula (II):



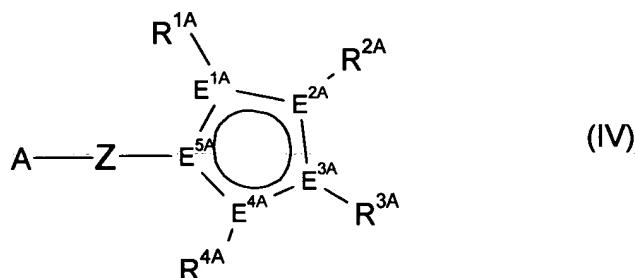
where the variables have the following meanings:

E^{1A} - E^{5A} are each carbon or not more than one E^{1A} to E^{5A} is phosphorus,

R^{1A} - R^{5A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}_2 , $N(SiR^{6A}_3)_2$, OR^{6A} , $OSiR^{6A}_3$, SiR^{6A}_3 , BR^{6A}_2 , where the organic radicals R^{1A} - R^{5A} may also be substituted by halogens and two vicinal radicals R^{1A} - R^{5A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{1A} - R^{5A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S, with 1, 2 or 3 substituents R^{1A} - R^{5A} each being a -Z-A group and

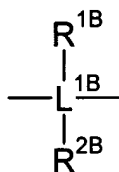
R^{6A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring.

4. A monocyclopentadienyl complex as claimed in any of claims 1 to 3, wherein the cyclopentadienyl system Cp together with -Z-A has the formula (IV):



where the variables have the following meanings:

- $E^{1A}-E^{5A}$ are each carbon or not more than one E^{1A} to E^{5A} is phosphorus,
- $R^{1A}-R^{4A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}_2 , $N(SiR^{6A}_3)_2$, OR^{6A} , $OSiR^{6A}_3$, SiR^{6A}_3 , where the organic radicals $R^{1A}-R^{4A}$ may also be substituted by halogens and two vicinal radicals $R^{1A}-R^{4A}$ may also be joined to form a five- or six-membered ring, and/or two vicinal radicals $R^{1A}-R^{4A}$ are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S,
- R^{6A} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring,
- Z is a bridge between A and Cp of the formula,



where

L^{1B} are each, independently of one another, carbon or silicon,

R^{1B}, R^{2B} are each, independently of one another hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{3B}_3 , where the organic radicals R^{1B} and R^{2B} may also be substituted by halogens and the two radicals R^{1B} and R^{2B} and/or R^{1B} or R^{2B} and A may also be joined to form a five- or six-membered ring,

R^{3B} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{3B} may also be joined to form a five- or six-membered ring and

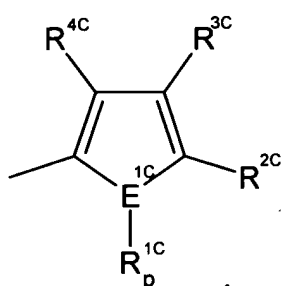
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A is an unsubstituted, substituted or fused, five-membered heteroaromatic ring system.

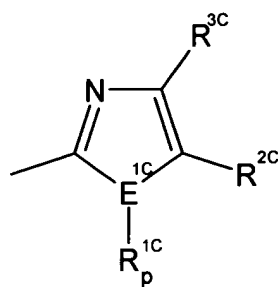
5. A monocyclopentadienyl complex as claimed in any of claims 1 to 4, wherein A has the formula (IIIa) or (IIIb)

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(IIIa)



(IIIb)

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where

E^{1C} is nitrogen, phosphorus, sulfur or oxygen,

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R^{1C} - R^{4C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{5C}_3 , where the organic radicals R^{1C} - R^{4C} may also be substituted by halogens or nitrogen or further C_1 - C_{20} -alkyl groups, C_2 - C_{20} -alkenyl groups, C_6 - C_{20} -aryl groups, alkylaryl groups having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{5C}_3 and two vicinal radicals R^{1C} - R^{4C} or the two radicals R^{1C} or R^{4C} and Z may also be joined to form a five- or six-membered ring,

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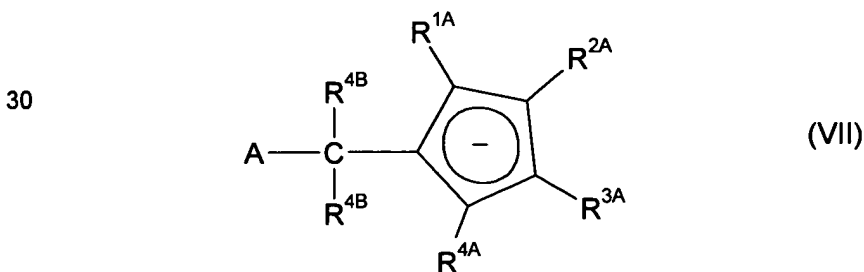
R^{5C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{5C} may also be joined to form a five- or six-membered ring and

p is 0 when E^{1C} is sulfur or oxygen and 1 when E^{1C} is nitrogen or phosphorus.

6. A monocyclopentadienyl complex as claimed in any of claims 1 to 5, wherein L^{1B} is carbon.

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7. A monocyclopentadienyl complex as claimed in any of claims 1 to 6, wherein Z is $-\text{CH}_2-$, $-\text{C}(\text{CH}_3)_2-$, $-\text{CH}(\text{C}_6\text{H}_5)-$ or $-\text{C}(\text{C}_6\text{H}_5)_2-$.
8. A catalyst system for olefin polymerization comprising
- 5 A) at least one monocyclopentadienyl complex as claimed in any of claims 1 to 7,
- B) optionally an organic or inorganic support,
- 10 C) optionally one or more activating compounds,
- D) optionally one or more catalysts suitable for olefin polymerization and
- 15 E) optionally one or more metal compounds containing a metal of group 1, 2 or 13 of the Periodic Table.
9. A prepolymerized catalyst system comprising a catalyst system as claimed in claim 8 and one or more linear C_2 - C_{10} -1-alkenes polymerized onto it in a mass ratio of from 1:0.1 to 1:1 000, based on the catalyst system.
- 20 10. The use of a catalyst system as claimed in claim 8 or 9 for the polymerization or copolymerization of olefins.
11. A process for preparing polyolefins by polymerization or copolymerization of olefins in the presence of a catalyst system as claimed in claim 8 or 9.
- 25 12. A process for preparing cyclopentadienyl system anions of the formula (VII),



35 where the variables have the following meanings:

- R^{1A} - R^{4A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}_2 , $\text{N}(\text{SiR}^{6A}_3)_2$, OR^{6A} , OSiR^{6A}_3 , SiR^{6A}_3
- 40 where the organic radicals R^{1A} - R^{4A} may also be substituted by halogens and two

vicinal radicals R^{1A} - R^{4A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{1A} - R^{4A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S,

5 R^{6A} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring,

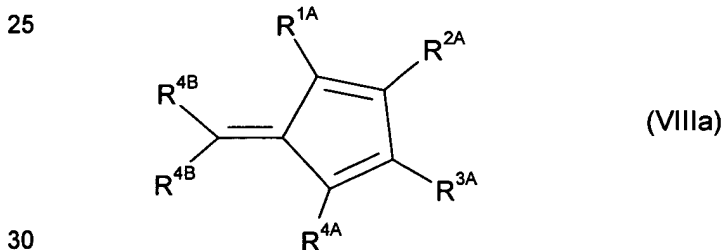
10 A is an unsubstituted, substituted or fused, heteroaromatic 5-membered ring system,

R^{4B} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{3B}_3 , where the organic radicals R^{4B} may also be substituted by halogens and two geminal or vicinal radicals R^{4B} may also be joined to form a five- or six-membered ring and

R^{3B} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{3B} may also be joined to form a five- or six-membered ring,

which comprises the step a) or a'), where,

in step a), an A^- anion is reacted with a fulvene of the formula (VIIIa)



or,

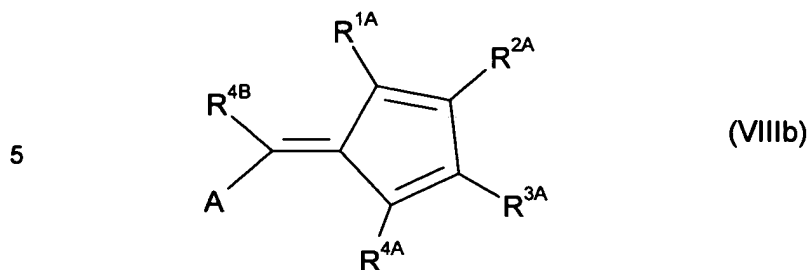
in step a'), an organometallic compound $R^{4B}M^BX^b$, where

M^B is a metal of group 1 or 2 of the Periodic Table of the Elements,

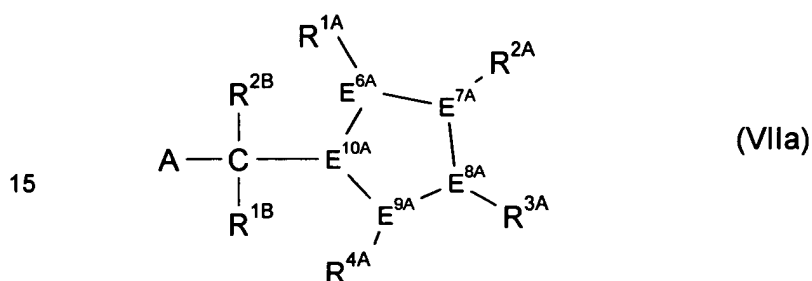
35 X^B is halogen, C_1 - C_{10} -alkyl, alkoxy having from 1 to 20 carbon atoms in the alkyl part and/or from 6 to 20 carbon atoms in the aryl part, or R^{4B} and

b is 0 when M^B is a metal of group 1 of the Periodic Table of the Elements and is 1 when M^B is a metal of group 2 of the Periodic Table of the Elements,

is reacted with a fulvene of the formula (VIIIb):



- 10 13. A process for preparing cyclopentadiene systems of the formula (VIIa)



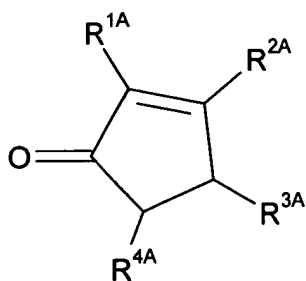
where the variables have the following meanings:

- 20 $E^{6A}-E^{10A}$ are each carbon, where in each case four adjacent $E^{6A}-E^{10A}$ form a conjugated diene system and the remaining $E^{6A}-E^{10A}$ additionally bears a hydrogen atom,
- 25 $R^{1A}-R^{4A}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}_2 , $N(SiR^{6A}_3)_2$, OR^{6A} , $OSiR^{6A}_3$, SiR^{6A}_3 , where the organic radicals $R^{1A}-R^{4A}$ may also be substituted by halogens and two vicinal radicals $R^{1A}-R^{4A}$ may also be joined to form a five- or six-membered ring, and/or two vicinal radicals $R^{1A}-R^{4A}$ are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S,
- 30 R^{6A} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring,
- 35 A is an unsubstituted, substituted or fused, heteroaromatic 5-membered ring system,
- 40 R^{1B}, R^{2B} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl, C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and

6-20 carbon atoms in the aryl part or $\text{SiR}^{3\text{B}}_3$, where the organic radicals $\text{R}^{1\text{B}}$ and $\text{R}^{2\text{B}}$ may also be substituted by halogens and $\text{R}^{1\text{B}}$ and $\text{R}^{2\text{B}}$ and/or $\text{R}^{1\text{B}}$ and A may also be joined to form a five- or six-membered ring,

5 $\text{R}^{3\text{B}}$ are each, independently of one another, hydrogen, $\text{C}_1\text{-C}_{20}$ -alkyl, $\text{C}_2\text{-C}_{20}$ -alkenyl, $\text{C}_6\text{-C}_{20}$ -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals $\text{R}^{3\text{B}}$ may also be joined to form a five- or six-membered ring,

10 which comprises the following step:
a'') reaction of an $\text{A-CR}^{1\text{B}}\text{R}^{2\text{B-}}$ anion, with a cyclopentenone system of the formula (IX)



(IX)

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